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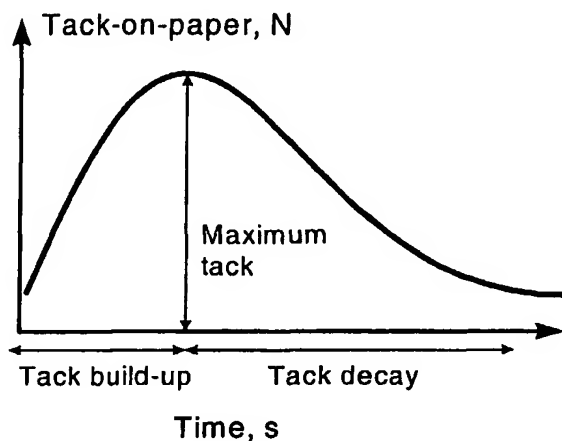
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(54) Title: PRINTED SUBSTRATE AND PRINTING METHOD



Picture 1. ISIT Tack Build-up curve

(57) Abstract: The invention refers to a printed substrate comprising a substrate with an oleophilic surface having a Gurley-Hill permeance value bigger than 5000s/100ml, the ink printed on the substrate having an IGT ink set-off value bigger than 0,60 at 30s delay time. The invention further comprises a method of printing a substrate in at least one printing unit under use off following substrate/ink combination: 1. The substrate has an oleophilic surface and is non-porous, i.e. has a Gurley-Hill permeance value bigger than 5000s/100 ml, 2. The pigment carrier/ink has an IGT ink set-off value larger than 0,60 at 30s delay time.

Printed substrate and printing method

1 Principles

The invention consists of a printed substrate that is a surface treated paper used is heatset offset printing. The invention also covers a printing method where the surface treated printed substrate is printed in the heatset offset printing method. The invented printed substrate can also be printed in gravure printing method.

Papers with appropriate surface properties are printed in the heatset offset method. In this printing method the printed item is transferred from the printing plate through an offset blanket onto the paper that is fed into the heatset offset printing machine as a continuous web. The transfer of the print item with ink consisting various degrees of pigment, binder, solvent and additives in the offset method is based on ink transfer from the smooth offset blanket. The ink has been transferred to the blanket from the printing plate where the ink has adhered on the oleophilic areas after the hydrophilic areas of the printing plate have been wetted by the fountain solution. Fountain solution consists of treated tap water, puffer, wetting agents and other additives. A printing plate working with dry offset (also called waterless offset) principal can also be used. In dry offset there is a silicon layer over the printing plate that repels the ink from adhering on the non-image areas of the printing plate. After the printed item has been transferred on the paper the ink will be dried with the help of heated air in order to evaporate most of the solvent from the ink. At the same time also the fountain solution transferred from the offset blanket and most of the moisture of the paper is evaporated. After the dryer the paper web is cooled in chill rolls where after the ink film is hardened and the printed paper web can be handled further.

Certain paper properties are required for a paper used in the heatset offset printing method. A paper with appropriate properties for this printing method is known for example from the European patent 539271 and the publication GB2047568. For these papers it is characteristic that calcium carbonate CaCO_3 pigment is used to optimize the porosity of the paper. The printing method itself has been described for example in the German patent publication DE 3207463.

In the earlier technique printing papers have been developed based on the fact that paper has to be porous to some degree so that it can absorb the fountain solution transferred from the offset blanket onto the paper and to

make easier the removal of the moisture from the paper as the ink is dried in the dryer.

The target of the invention is to introduce a new type of a printed substrate that has a surface structure suitable for the heatset offset printing method. To fulfill the demands for a printed substrate the printed substrate is mainly known from the characteristics that have been presented in the patent claims.

The target of this invention is also to present a heatset offset printing method in which the paper is fed as a continuous web into one or several printing units of the printing machine for ink transfer onto the paper after which most of the ink solvent is evaporated in the dryer with heated air in order to dry the ink and to present an ink that is easy to dry in the dryer.

The surface of the substrate is non-porous and oleophilic. By this definition it is meant that the oil displaces the fountain solution on the paper surface. The surface properties have been achieved by suitable paper treatment, especially by coating and finishing thereafter. In order to avoid problems related to ink transfer and drying the printed substrate differs from the printing papers used in the heatset offset printing method nowadays as the surface of present papers is porous and water absorbing. The invented printed substrate makes it possible to dry the ink as a surface phenomenon. The printing ink used also differs from the normal inks used today in the heatset offset method because the solvent of the ink evaporates faster in lower air temperatures in the dryer (lower solvent content and/or oil boiling in low temperature and a low solvent retention to the ink binder enabling fast solvent removal) which makes it an easier drying ink. The non-porous surface of the paper allows the use of an easily drying and a fast setting ink (no problems related to fast ink setting, see ink setting definition in clause 3.1). The combination of a non-porous paper surface and an easily drying ink makes it possible to use lower air temperatures in the dryer while at the same the paper moisture content remains high and the ink solvent evaporates. Also the surface properties decrease the amount of fountain solution transferred on the paper (oleophilic non-porous surface repels the fountain solution and prevents it's penetration into the paper structure).

The printed substrate described in the patent makes it possible to optimise the fountain solution used in the heatset offset printing process so that the wetting agent of it is favourably a non-alcohol type.

The invention provides an essential print quality improvement which is based on the fact that drying can be performed with web end temperatures lower than 100 °C measured from the web right after the dryer. With this low drying temperatures on one hand fast moisture removal is prevented and on the other hand the moisture content after drying is higher than in conventional solutions. This is advantageous as fast moisture removal causes fiber roughening and waviness that decrease print gloss and uniformity. The benefits from higher paper moisture content after drying are improved print quality and performance in folding unit after drying. Further, the folding performance is improved because paper stands folding better with higher moisture content and cracking potential is decreased. The higher moisture content also decreases the static electricity that is beneficial for finishing process. It is also easier for the printer to handle unprinted paper, as no wrapping paper is needed because the paper moisture content is near the balance with air moisture content.

The benefits of the invention for paper makers are increased moisture content, lower strength demand and improved production efficiency. The moisture content can be higher because the paper moisture is not evaporated in drying and the heatset offset problem blistering does not occur. As there is no risk for blistering paper strength can be lowered which enables the possibility of using lower prize furnish for base paper and decreasing the need for sizing the paper. Decreasing sizing makes it possible to increase the production speed due to better water removal. Using the invented printing substrate with a recipe suitable also for gravure printing method it is possible to cut the finished paper machine rolls at the same time for gravure and heatset offset printing methods for high quality printing and thus decrease the waste paper amount and improve production efficiency.

The non-porous paper improves paper runnability and printability. As the paper does not absorb fountain solution from printing units no changes in paper dimensions take place and problems like miss register or fan-out do not occur. There is no ink setting as there are no pores in the printing substrate. There fore problems related to ink setting like back-trap mottling, back-trap picking or carry-over piling do not occur. This improves the print result and makes longer print runs possible because of less printing blanket washing needed.

The new printing concept is environmentally friendly because the fountain solution used in non-alcohol type reducing the VOC emissions and lower energy needed in drying due to low air temperature in the drying process. The ink solvent content of the print is low.

The printed substrate invented covers the following conditions:

- 1) The IGT Ink Set-off value at 30 s delay time is bigger than 0,60 and
- 2) Gurley—Hill Air Permeance Test value is bigger than 5000 s/100 ml. The Set-off value is a measure for capillary suction of paper surface. The result of the IGT measurement gives a value for ink setting speed that correlates with the paper surface porosity. Gurley-Hill value is a measure for porosity.
- 3) The Tack-Build-up time of the ISIT measurement is advantageously more than 100 seconds with a printing ink that has stability in the Tack-O-Scope ink tack measurement T_{\max} 270 – 300 seconds. This stability result can be reached with for example with a know Sun Challenge ink. The result of the ISIT measurement gives a value for ink setting speed that correlates with the paper surface porosity.

The printed substrate is advantageously a coated paper or surface treated paper or board that contains plate like pigments as coating pigment. The surface properties of paper can be further adjusted by the choice of coating pigment and latex (coating binder) types and their amounts. The aspect ratio of the plate like pigment particle that is the relation of the pigments diameter to the thickness of the pigment particle is more than 2 and advantageously more than 4. The aspect ratio is advantageously bigger than 4 to achieve a non-porous surface. The pigment used in the coating colour is therefore advantageously talc as a sole pigment or a combination of kaolin and talc pigments. The high aspect ratio of the plate like talc is advantageously more than 25 and affects positively in decreasing the porosity of the paper surface. In the same way the softer the latex used is (low T_g value, T_g is the glass transforming temperature) and the more latex used in relation to the amount of pigment is the more closed (non-porous) the surface is. Also the cross-linking of the latex binder improves closeness of the surface.

The invention is described more detailed in the following part by referring to some examples that do not restrict the use of the invention.

2 Papers

The base paper in the invented paper was a typical LWC base paper with an ash content of 12 % and a fibre mix of 40 % chemical pulp and 60 %

of mechanical (TMP) pulp. The basis weight was approximately 36 g/m² and the density approximately 660 kg/m³. The paper was coated with a coating receipt of following components

Talc (C10XO or C15)	pigment
Kaolin (Supragloss95)	pigment
Styrene Butadiene latex (Rhodopas 388)	latex binder
Starch (Raisamyl 302)	binder
Styrene maleic anhydride (Raisaprint D100 or D200)	adjustment of surface chemical properties
Calcium stearate (Raisacoat 50)	add agent for calendering
Optiblanc NF	optical brightener
Glyoxal	cross-linker

The solid content of the coating colour was 58 % and the pH 7,5. The T_g value of Rhodopas 288 was 0 °C that is a lower T_g value than with latexes normally used in coating colours for heatset offset method. The surface closeness can be improved with a T_g value lower than 5°C.

Various coating colour recipes for the invented paper are presented in the table 1 (as parts of weight).

Table 1. Coating colour recipes

Coating colours	1	2	3	4	5	6	8
C10XO	70	70			40	70	70
C15			70	100			
Supragloss	30	30	30		60	30	30
Rhodopas SB 388	10	15	10	10	10	10	10
Raisamyl 302	2	3	3	3	3	3	3
D200		3	3	3	3	3	
D100	1						
Raisacote 50	0,5	0,5	0,5	0,5	0,5	0,5	0,5
Optiblanc	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Glyoxal	0,2	0,2	0,2	0,2	0,2	0,2	0,2

*D100 was boiled together with the starch.

The paper was coated with the blade coating (Opticoat-Jet). The upper (rougher) side of the 36 g/m² base paper was coated first. The target amount of coat weight was 12 g/m² on both sides of the paper (12 + 12

g/m² coating) and the final coated paper grammage was 60 g/m². The target final moisture content was 5,3 % before calendering.

The web was dried after coating with infrared dryers and airborne web-dryers.

The coated paper was reeled into rolls. The rolls were supercalendered so that the upper side was against the first chilled roll. The conditions in supercalendering were as follows:

Temperature	
upper:	120 °C
middle:	110 °C
bottom:	90 °C
Nip load	320 kN/m
Speed	500 m/min
Nip amount	9

The properties of the final the two-side coated papers are listed in table 2. The numbers refer to the number of the coating colours and corresponding sample number.

Table 2. Properties of final coated papers

	Unit	Coating colour/sample					
		1/2	5/8	6/10	3/12	8/18	4/22
Physical properties							
Basis weight	g/m²	59,8	61,7	61,7	62,7	62,7	63,7
Amount of coating colour	g/m²	9,7	12,0	13,1	12,6	12,8	12,7
Thickness	μm	48	49	49	48	48	48
Density	kg/m³	1239	1262	1265	1298	1302	1319
Bulk	dm³/kg	0,81	0,79	0,78	0,77	0,77	0,76
Surface properties							
Roughness PPS 10 ts*)	mμ	0,96	1,05	1,04	1,07	0,93	1,10
Roughness PPS 10 ws**)	μm	0,99	1,01	0,91	0,91	0,73	1,10
Gloss ts*)	%	63,0	65,7	63,3	59,4	65,2	49,1
Gloss ws**)	%	58,6	67,2	64,5	59,3	65,0	48,6
Optical properties							
Brightness Elrepho ws**)	%	74,5	73,3	73,4	71,7	73,6	72,9
Luminance ws**)	%	78,0	77,6	77,2	76,2	77,1	76,4
Opacity ws**)	%	91,3	91,0	91,0	90,2	91,5	89,6
Dominant wave length ws**)	nm	573	574	573	574	573	573
Excitation purity ws**)	%	3,2	3,9	3,5	4,2	3,4	3,4
Porosity and absorption properties							

NP ink absorption ws**)		27,3	17,4	18,4	18,1	20,1	27,3
K&N ink absorption ws**)		2,7	1,3	1,3	1,5	1,5	3,4
Printability properties							
IGT surface strength ws)	m/s	0,50	0,60	0,66	0,65	0,65	0,58
IGT surface strength wsrd***)	m/s	0,53	0,63	0,75	0,78	0,78	0,68
IGT surface strength wsard****)	m/s	0,48	0,58	0,58	0,53	0,53	0,48

* ts = top side

** ws = wire side

*** wsrd = wire side measured in running direction

**** wsard = wire side measured against running direction

The small number in the K&N ink absorption test (in each case under 4 %) already shows that the surfaces of the papers in question are very closed and non-absorbing.

The following commercial and known heatset offset papers were used in the comparison test:

SCO	UPM Max 56 g/m ²
LWCO	UPM Cote 60 g/m ²
LWCO	UPM Ultra 70 g/m ²
LWCO	UPM Ultra M 70 g/m ²
MWC	UPM Star 100 g/m ²
WFC	UPM Art 100 g/m ²

SCO is a supercalendered paper for heatset offset, LWCO is a light weight coated paper for heatset offset printing method, MWC is a medium weight coated paper for heatset offset and WFC is a wood free coated paper used in heatset offset method. The properties of the known papers have been analysed with following methods.

The closed surface is also suitable in heatset offset method and in gravure printing method for different kinds of papers and boards .

3 Methods

The significance of a test method is its ability to characterize the surface porosity of the paper independent of paper bulk or thickness or surface roughness. Absorption methods suit best to characterize the paper surface as absorbance and porosity depend on each other. Set-off at 30 seconds delay time with IGT Printability Tester, ISIT Tack Build-up Method and

K&N Ink Absorption Tests are based on capillary absorption and paper bulk effect is eliminated. The surface roughness affects the K&N result and therefore these results are guiding. Gurley-Hill Air Permeance measures the paper porosity. Gurley-Hill Air Permeance values are used together with IGT Set-off at 30 s delay time values in order to separate uncoated porous papers from the invented closed surface coated papers.

3.1 Set-off at 30 s delay time, Ink requirement and Print gloss with IGT-type printability tester

Set-off is a measure of the speed of ink setting on paper. In ink setting the ink film on paper hardens as the capillary forces caused by paper surface porosity absorb the solvent component of offset ink. Ink setting speed is high for micro porous paper coating surfaces and low for closed non-porous paper surfaces and also for uncoated papers that contain larger size pores that cannot form high capillary forces.

Ink requirement is a measure for the amount of ink needed for certain optical print density. Print density is the ability of printed image to absorb and reflect light and it correlates with the colour strength or darkness of colour seen by the human eye. Lower ink requirement is advantageous for good print quality.

Ink gloss is a measure for the print quality. High print densities can only be reached with a high print gloss.

3.1.1 Introduction

This method describes the procedure to be adopted when using an IGT-type printability tester to prepare prints on paper. IGT Printability Testers are manufactured by the IGT Testing Systems b.v., Amsterdam Netherlands. The following properties of printed paper are measured in this method:

- a) Set-off at 30 s delay time that correlates with ink setting speed and surface porosity
- b) Ink requirement which means the amount of ink needed for certain print density (see Clause 3.1)
- c) Print gloss which is the ink gloss measured at certain ink amount

Warning – Precaution shall be taken when making a comparison between printing results from different laboratories or from different printability testers, see Clause 10

3.1.2 References

The following Scandinavian SCAN-methods made by the Scan Test Secretariat are referred in this method:

SCAN-G 1 Pulps, papers and boards – Reflectance factor - General procedure of measurement (ISO 2469)

SCAN-P 2 Papers and boards – Conditioning of test samples (EN 20187, ISO 187)

SCAN-P 8 Papers and boards – Opacity and Y-value, light scattering and light absorption ($C/2^\circ$) coefficients (ISO 2471)

SCAN-P 9 Papers and boards – Identification of machine and cross directions

SCAN-P 10 Papers and boards – Identification of wire side

SCAN-P 36 Papers and boards – Evaluation of test prints

3.1.3 Definitions

For the purpose of this method the following definitions apply:

3.1.3.1 *Print density, \tilde{D}* The logarithm to base 10 of the ratio of the Y-value of the unprinted paper to the luminous reflectance factor of the print when it is placed over a pad of the unprinted paper.

3.1.3.2 *Set off at 30 s delay time, \tilde{t}* A measure of the tendency for ink from a newly printed surface to be transferred to another surface with which the print is brought into contact under the action of a normal force without shear. The set-off is evaluated as the logarithm to base 10 of the ratio of the Y-value of the recipient surface to the luminous reflectance factor of the area stained by ink transfer when the stained paper is placed over a pad of the recipient paper. The set-off delay time is 30 s from ink transfer to set-off contact. The Set-off at 30 s delay time is given in print density units.

Note The recipient paper may be a standard paper or a sheet of the paper being tested. Other print quality definitions are given in SCAN-P 36.

3.1.4 Principle

A cylindrical printing form consisting of a disc covered with plastic

coated rubber is inked in an inking unit. The paper or board to be printed is mounted on a cylindrical sector. Printing takes place under standard conditions.

The amount of ink transferred to the paper is calculated by weighing the printing disc before and after printing.

When set-off is determined, the fresh print is brought into contact with a clean recipient paper in a second printing nip under normal pressure without shear 30 s after the printing.

3.1.5 Apparatus

3.1.5.1 *Printability tester* consisting of a printing unit with two adjustable printing nips.

3.1.5.1.1 *Printing unit* incorporates a motor-driven sector which rotates with constant and adjustable speed against a printing disc and when measuring set-off, also against a second disc. The force between the printing disc and the sector is achieved by means of an adjustable spring. It is also possible to adjust the delay time used for set-off purposes.

Note 1 – It is important that the instrument is properly calibrated. The manufacturer of the apparatus supplies accessories for the calibration of both speed and force.

3.1.5.1.2 *Cylindrical printing disc* of aluminium, 68 mm in diameter and 32 or 50 mm wide, covered with plastic coated rubber (to avoid absorption of ink vehicles) that has the hardness of about 85° Shore A. The width of the disc must match that of the sector. The disc must be light enough to be weighed on an analytical balance with a precision of 0,1 mg.

Note 2 – The rubber deteriorates with use and time, and the discs should be kept in the dark at room temperature.

3.1.5.2 *Inking unit* to give a uniform ink film on the printing disc.

3.1.5.3 *Analytical balance* with an accuracy of at least 0,1 mg.

3.1.5.4 *Ink pipette*, or other suitable device for transferring an appropriate amount of ink to the inking device.

3.1.5.5 *Printing ink.* Standard lithographic offset ink manufactured by Michael Huber, Munich Germany, is used. The trade name of the ink is in German “Wegschlagtestfarbe” and in English “Setting Test Ink”, ink number 520068, the batch number in test was 00122615.

Note 3 Due to the fact that ink is made out of natural raw materials it is impossible to have exactly constant ink properties from batch to batch. Therefore the results of the tests also may vary and a correction to the test conditions are needed accordingly, see clause 10.2.

3.1.5.6 *Solvent for cleaning purposes.* Petroleum ether alone or white spirit followed by petroleum ether is suitable.

Note 4 Cleaning liquids containing surfactants or non-volatile components should not be used.

3.1.5.7 *Set-off paper.* A cast-coated paper “New Ojo” used in the method is manufactured by Oji Paper from Japan and is available through their agents.

3.1.6 Sampling and preparation of test

The sampling procedure is not covered in this method. Make sure that the test pieces taken are representative of the sample received. Condition the samples as indicated in SCAN-P 2 and keep them in the conditioned atmosphere throughout the test.

Note 1 Because the viscosity of the ink is temperature dependent, temperature control is as important for this test as humidity control.

Cut the test samples to the dimensions suitable for the printability tester. Normally, the test-pieces strips should be cut in the machine direction (see SCAN-P 9) to simulate web offset printing. The direction of printing must be stated in the report. The pieces should be free from folds and wrinkles. Mark the side to be printed.

Note 2 – For subsequent evaluation according to SCAN-P 36, at least five strips are required.

3.1.7 Procedure

3.1.7.1 *Test conditions*

3.1.7.1.1 *Temperature* – If the equipment has an internal temperature controller, make sure that the testing equipment, inking unit and printing disc and the test material are maintained at the correct temperature ($23 \pm 0,5$ °C).

3.1.7.1.2 *Printing disc* – Select a disc with a plastic coated rubber surface which match the width of the sector (3.1.5.1.3). Use the same kind of discs in set-off contact as in printing.

3.1.7.1.3 *Inking the printing disc* Introduce ink into the inking unit and ink the printing disc in accordance with the manufacturer's instructions.

3.1.7.1.4 *Printing pressure* Set the printing force to 650 N for the 50 mm wide printing disc and to 415 N for the 32 mm wide printing disc to give a line load of (13 ± 1) kN/m. If set-off is to be measured, use the same line load in the second printing nip.

3.1.7.1.5 *Printing speed* Adjust the printing speed to 1,0 m/s.

Note – If there is a risk for picking the following procedure is used. Attach a piece of plastic tape to the areas on the paper where the cylinder stops against the printing disc during printing, because in those places the risk of picking is the greatest. This must be stated in the report.

3.1.7.1.6 *Delay time* –The delay time between ink transfer and set-off is 30 s.

3.1.7.2 *Test procedure* Fasten the front end of the test piece to the sector. Adjust the test piece so that it is flat on the sector and fasten the other end of the test sample. Fasten a strip of set-off paper on the second printing disc and mount the disc to the second shaft. Weigh the inked printing disc and place it in position on the shaft. Bring the printing disc into contact with the sector and print the test piece. Remove the printing disc and weigh it immediately. After ink transfer the print is pressed against the cast-coated set-off paper after a delay time of 30 s. Save the printed test sample and the cast-coated set-off papers for optical measurement (24 ± 2) hours later. The strips must be saved for later measurement according to SCAN-P 36

Print a total of four test pieces with four different ink quantities. Print first

with the lowest ink quantity and increase stepwise so that new ink is continually applied to the inking unit. Clean the printing disc after each printing. Clean the inking unit after each test series, i.e. after four printings.

Note 2 – After cleaning the printing disc with solvent, wipe the surface dry and give the solvent sufficient time to evaporate.

Choose the four ink quantities so that they cover a range of ink on paper from 0,7 g/m² to at least 2,0 g/m². The print properties are evaluated by determining the print density in an instrument conforming to the requirements of SCAN-G 1 (see SCAN-P 36).

3.1.8 Calculations

3.1.8.1 Determination of Ink amount on paper

Calculate the mass per unit area of ink transferred to each test piece according to:

$$W = \frac{(G1 - G2)}{A}$$

where

- W* is the ink transferred, in grams per square meter;
- G1* is the mass of the printing disc before printing, in grams to the nearest 0,1 gram;
- G2* is the mass of the printing disc after printing, in grams to the nearest 0,1 gram;
- A* is the area of the print, in square meter, the area of the print is the same as the surface area of the printing disc

3.1.8.2 Determination of Ink requirement

The results are drawn in a diagram where the X-axis is the amount of ink on paper and Y-axis is the print density of the printed paper. A curve is drawn with the four ink amounts and corresponding print densities. The Ink requirement is interpolated from the curve at the point when ink amount on paper is 1,50

3.1.8.3 Determination of Set-off at 30 s delay time

The results are drawn in a diagram where the X-axis is the amount of ink on paper and Y-axis is the set-off print density of the cast-coated set-off paper. A curve is drawn with the four ink amounts and corresponding set-off print densities measured from the cast coated paper. The Set-off at 30 s delay time is interpolated from the curve at the point when ink amount is 1,50 g/m².

3.1.8.4 Determination of Print gloss

The results are drawn in a diagram where the X-axis is the amount of ink on paper and Y-axis is the print gloss of the sample. A curve is drawn with the four print densities and corresponding print gloss values. The Print gloss is interpolated from the curve at the point when ink amount is 1,50 g/m².

3.1.9 Report

The test report shall include reference to this SCAN-test Method and the following particulars:

- (a) Time and place of testing;
- (b) Identification of the test material
- (c) Make and type of printing press;
- (d) Type and name of printing ink used including the manufacturer and the batch number;
- (e) The amount of ink per unit area transferred to each test piece, to the nearest 0,01 g/m²;
- (f) The type and grammage of the set-off paper used;
- (g) The delay time before set-off
- (h) For each test piece, the time at which the printing was made.
- (i) Any departure from this method, which may have affected the results.

3.1.10 Reproducibility

The properties of the Setting Test Ink 520068 may change from batch to batch. In order to have comparable results between laboratories and ink batches the following correction should made to the test conditions.

Use the same coated paper and Setting Test Ink of batch 00122615 and Setting Test Ink of the new batch. Print the paper with the inks according to the test method with the both inks. If the Set-off values for the two inks differ then change the delay time from ink transfer to set-off contact so

that Set-off at 30 s delay time value is the same for both inks at the accuracy of $\pm 0,03$ print density units. If the Set-off value of the new batch is higher than the reference batch then increase the 30 s delay time from ink transfer to set-off contact and if the Set-off value is lower then decrease the delay time.

Note – All changes in test printing conditions must be reported.

3.2 ISIT Tack-Build-Up method

3.2.1 Principle

The papers were tested with the ISIT method that gives the Ink Tack Build-up time that correlates with the ink setting speed. Ink tack describes the force needed to split an ink film. The value is achieved with Ink/surface Interaction Tester ISIT device ("ISIT device"), manufactured by SeGam Ltd, UK. First a controlled ink amount is transferred onto the tested paper and after a specified time the ink tack is measured. The speed of ink tack increase after ink transfer correlates with the ink setting speed that depends on the surface pore structure. Ink setting speed is slow with non-porous surfaces and fast with micro porous paper coatings.

A commercial IGT inking unit and IGT printing disc are used for preparation and transfer of ink. The procedures in ink transfer are similar as in IGT Set-off at 30 s delay time method (see Clause 3.1.7). Ink tack on paper is measured with a special attachment that consists of a solenoid, a coil spring a load cell and a contact disc. The contact disc is pressed against the ink on paper by electromagnetic force. The contact disc is separated from the print (ink on paper) by the strain force of the extended coil spring. The strain gauge, fixed between the contact disc and the coil spring, generates a load-dependant signal that is recorded as the measured tack force. After the measurement the contact disc and print change places so that the next contact with the disc and ink on paper happens between clean contact disc and untouched ink surface. The build-up of the tensile force required to split the ink layer is measured automatically so that the contact disc has successive separations from the print and each individual separation is recorded.

3.2.2 Tack Build-up time

The result of the test is a function of ink tack (Y-axis Tack-on-paper) vs. ink setting time (x-axis Time) and the Tack Build-up time (s) is the time from the moment of ink transfer onto paper to the time when the

maximum tack value is reached, see picture 1. In practice the tack value is the force needed to separate the contact disc from the ink layer that is on the printed substrate. This method can be used to separate different paper surface properties when using the same printing ink but different papers. The longer the time for the maximum tack with the same ink the more non-porous (closed) the surface is. Picture 1

3.2.1 Test conditions in the ISIT Tack Build-up method

The conditions in the ISIT Tack Build-up method were following:

Applied ink amount	100 mm ³
Transferred ink amount	1.4 g/m ² Sun Challenge 1.5 g/m ² Sicpa Mediatech Ultra Fast
Ink leveling time	5 s in the rollers + 5 s with the disc
Ink leveling speed	0.7 m/s
One printing and the washing of the rollers	
Ink transfer, pressure	15 kN/m
Printing disc	20 mm, rubber surface
Time with the contact disc	0.5 s
Pressure with contact disc	8 (no dimension)
Separation speed of contact disc	5 (no dimension)
Time intervals between printing and contact	1.9 s, 7.6 s, 13.3 s, 19.0 s, 39.6 s, 60.3 s, 80.9 s, 121.6 s, 162.3 s, 203.0 s, 303.6 s, 404.2 s, 504.8 s

3.4 K&N ink absorption test

The papers were tested with the K&N ink absorption test. The method description is here:

Ink absorption with the K&N ink

3.4.1 Principle

The test ink is spread on the paper for a specific time. The density of the colour is a measure to the absorption ability of the paper. The reflectance value is measured.

3.4.2 General

First a test ink layer covering the paper surface is spread on the paper. The part of the ink that has not been absorbed into the paper will be

removed and the reflectance value of the inked paper is measured with an Elrepho colour measurement device. The absorption properties of the both sides of the paper are measured separately, 2 tests per side. The test ink is spread on the side that is tested.

3.4.3 K&N ink

K&N ink is used mostly with coated paper grades (ink absorption time 2 min).

- The sample is cutted into 4 slices of size 8 x 25 cm so that the longer side is in machine direction.
- The tested paper slice is mounted on a glass plate so that two of the slices are upper side of the paper up and two bottom of side of the paper up.
- Ink is spread on the paper over an area of about 5 x 8 cm size and the rest of the test paper is left clean. It is recommended to use a protection paper over the clean area of the test paper.
- The K&N ink is carefully mixed in the can. An ink layer that covers the paper surface is spread on the paper and the timer is switched immediately on.
- The ink absorption takes place for 2 min where after the excessive ink on the paper surface is wiped away first with a trowel and thereafter with a cloth. The wiping is continued until there is no change in the lightness of the inked area, normally 5 – 6 times.
- The amount of ink should as high enough so that it is not possible that all the ink is absorbed into the paper.
- The tested papers are moved to hanging in a line so that there is no obstacle for ink drying. The reflectance measurement will be done after 2 hours. The time for measurement is written down.

3.4.4 Settings of the colour measurement

1. The power is switched on.
2. A lamp warming time of 5 min is needed before the measurement can start.
3. Check that the gray filter is on: the sign on the lid is visible.

Measurement of the reflectance value

1. Zero the gauge
 - The filter switch is on position 12

- The indicator is adjusted to show zero with the zero potentiometer. The adjustment button is pushed down and the zero point is adjusted again.
- 2. Filter 10 is switched on with the filter selector
 - The inner standard is moved away.
- 3. The gauge is adjusted to show 100 on the clean area of the test print
 - A pile of tested paper is placed on the carrier plate where the paper on top is the inked paper. The pile of paper and tested papers are always on the same side.
 - The clean area of test paper is mounted under the measuring opening and the value 100 is adjusted to measuring drum.
 - The gauge is first adjusted to zero only by turning the measuring drum and thereafter again with adjustment button.
- 4. Measurement of the reflectance value of the inked area
 - The inked area of the test slice is moved under the measuring opening.
 - The indicator is adjusted first to show zero only by turning the measuring drum and thereafter again with the adjustment button.

The reflectance value is directly the number on the measuring drum. The reading is taken with the accuracy of 0,1 unit. The reflectance value of each test paper is measured in the same manner. One measurement is done from the test paper.

3.4.5 Calculation of the result

$K\&N \text{ value} = 100.0 \% - \text{the measured reflectance value, \%}$

3.5 Gurley—Hill Air Permeance Test

Gurley-Hill value is measured according to standard T536 om-88. A high value means that the paper is non-porous as a long time is needed for 100 ml gas to penetrate through the paper.

4 Printing inks

This ink can be characterized best in relation to the paper porosity with the stability value that is received from the Tack-O-Scope tack measurement that is a known method in printing ink industry. In the Tack-O-Scope measurement the ink tack that is a measure for the force needed to split an ink layer increases from starting moment as the solvent of the ink starts to evaporate until it reaches a maximum value where

after the tack decreases as the ink starts to dry. For a fast drying ink that is favorable for the invented heatset offset printing method the T_{\max} value is low.

The measuring conditions in the Tack-O-Scope test were as follows:

ink amount	0.4 g
stabilizing time	30 s
stabilizing speed	100 m/min
testing speed	200 m/min
temperature	25 °C.

5 Results

The results refer to coating colour and sample numbers that are explained in clause 2 Papers.

5.1 Set-off at 30 s delay time, Ink requirement and Print gloss with IGT-type printability tester

The results from IGT Set-off at 30 s delay time are in table 3.

Table 3: IGT set-off at 30 s delay time, Ink requirement and Print gloss

	Measurement	On paper Ink amount g/m ²	Print gloss %	Print density	Set-off density 30 s delay	Paper gloss %	On disc Ink amount g/m ²	set-off % 30s %	Ink transfer %
Coating colour 5 Sample 8	1	0.78	62.7	1.02	0.32	63.1	1.38	31.0	56.8
	2	1.10	72.4	1.31	0.60	70.5	2.12	45.6	51.9
	3	1.51	77.1	1.52	0.87	70.9	2.86	57.5	52.6
	4	2.09	80.3	1.75	1.11	68.5	4.01	63.6	52.2
	Interpolation	1.50	74.8	1.47	0.80	68.3	2.83	52.6	52.98
Coating colour 6 Sample 10	1	0.79	62.1	0.99	0.33	60.7	1.29	33.3	61.2
	2	0.96	70.2	1.15	0.53	68.4	1.83	45.7	52.5
	3	1.40	79.1	1.47	0.83	66.8	2.72	56.3	51.5
	4	2.10	78.7	1.72	1.15	65.6	4.06	66.9	51.9
	Interpolation	1.50	74.7	1.41	0.82	64.5	2.86	55.0	53.19
Coating colour 3 Sample 12	1	0.72	63.9	0.94	0.32	61.6	1.24	33.6	58.1
	2	1.07	66.2	1.21	0.51	59.6	2.04	42.1	52.4
	3	1.46	71.3	1.46	0.82	62.0	3.00	55.8	48.5
	4	2.07	75.7	1.68	1.07	59.9	4.08	63.7	50.9
	Interpolation	1.50	70.8	1.41	0.78	60.8	2.95	52.7	51.54
UPM Max 56 g/m ²	1	0.75	47.7	0.74	0.12	50.7	1.17	16.2	64.4
	2	1.26	50.3	1.11	0.38	50.6	2.26	34.4	55.7
	3	1.58	52.9	1.26	0.52	49.3	3.06	41.1	51.6
	4	2.13	58.3	1.48	0.82	47.9	4.38	55.1	48.7
	Interpolation	1.50	52.8	1.18	0.50	49.6	2.88	38.6	54.31
	1	0.85	59.3	1.00	0.05	65.7	1.38	4.8	61.90
	2	1.04	60.9	1.20	0.09	65.5	1.87	7.9	55.90

UPM Cote 60 g/m ²	3	1.62	64.8	1.49	0.25	65.9	2.84	18.9	57.00
	4	2.21	69.2	1.69	0.49	66.9	4.21	28.8	52.60
	Interpolation	1.50	64.1	1.38	0.24	66.0	2.72	15.8	56.50
UPM Ultra 70 g/m ²	1	0.75	66.8	0.94	0.04	68.5	1.37	4.7	55.1
	2	1.08	67.0	1.21	0.09	69.4	1.92	7.4	56
	3	1.65	70.5	1.56	0.28	68.1	2.96	18.3	55.7
	4	2.11	73.7	1.70	0.55	68.8	3.99	32.2	53
	Interpolation	1.50	70.0	1.41	0.28	68.7	2.76	17.7	54.77
Upm Star 100 g/m ²	1	0.79	67.8	1.05	0.02	77.7	1.27	2.1	62.2
	2	1.16	72.2	1.33	0.07	78.9	1.91	5.3	60.4
	3	1.58	74.3	1.55	0.14	76.6	2.64	8.8	60
	4	2.15	79.1	1.71	0.37	76.3	3.97	21.8	54.3
	Interpolation	1.50	74.0	1.45	0.17	76.9	2.61	10.6	58.78
Upm Art 100 g/m ²	1	0.82	66.6	1.06	0.01	69.4	1.18	1.1	69.5
	2	1.19	67.8	1.32	0.02	68.9	1.89	1.8	63
	3	1.7	71.9	1.57	0.06	69.2	2.77	4.1	61.3
	4	2.48	68.8	1.7	0.13	69.5	3.93	7.7	63.3
	Interpolation	1.50	68.7	1.41	0.05	69.3	2.36	3.5	64.39

Printing ink: Michael Huber Munchen setting test Ink 520068, batch 00122615

Place and time: UPM-Kymmene Rauma Mills, 15.3.2002

Set-off at 30 s delay time values for the invented papers are over 0,80 s, for the known uncoated paper is 0,79 and known coated papers less than 0,40. Ink requirement values (table 3 On paper Ink amount) for the invented papers and known coated papers are over 1,50 and for the known uncoated paper more than 2,00. Print gloss values for the invented papers and MWC and WFC papers are over 70 %, for the known uncoated paper under 60 %, LWCO papers over 65 %. Delta Print Gloss (Print gloss - Paper Gloss from table 3) is over 5 % for the invented papers, for the uncoated paper 7,6 %, for the LWCO papers less than 3 % and for MWC and FWC 0 %.

5.2. Gurley-Hill Air Permeance

The results of the Gurley-Hill Air Permeance measurement (G-H) were following:

Paper with the invented properties:

	G-H s/100ml
Coating colour 3 / sample 12	31690
Coating colour 5 / sample 8	13990
Coating colour 6 / sample 10	40260

The known papers

	G-H s/100ml
UPM Cote 60 gsm (LWCO)	3140
UPM Max 56 gsm (SCO)	360
UPM Star 100 gsm (MWC)	3430
UPM Ultra 70 gsm (LWCO)	2370
UPM Art 100 gsm (WFC)	2240

The invented papers have much lower air permeance.

5.3 ISIT Tack-Build-Up

The ISIT Tack Build-up curves and ISIT Tack Build-up times for the three known papers and for one paper invented (coating colours 3 / sample 12) with the Sun Challenge ink are presented in picture 2. The ISIT Tack Build-up time for the invented paper is over 400 s as the values for the known papers are less than 50 s.

The ISIT Tack Build-up curves and ISIT Tack Build-up times for two known papers and for two papers invented (coating colours 5 / sample 8 and coating colours 6 / sample 10) with the Sun Challenge ink are presented in picture 3. The ISIT Tack Build-up times for the invented papers are over 300 s as the value for the known uncoated paper is 136 s and known coated paper less than 25 s.

The ISIT Tack Build-up curves and ISIT Tack Build-up times for the three known papers and for one paper invented (coating colours 3 / sample 12) with the SICPA Mediatech Ultra Fast ink are presented in picture 4. The ISIT Tack Build-up time for the invented paper is over 200 s as the values for the known papers are clearly less than 10 s.

The ISIT Tack Build-up curves and ISIT Tack Build-up times for two known papers and for papers invented (coating colours 5 / sample 8 and coating colours 6 / sample 10) with SICPA Mediatech Ultra Fast ink are presented in picture 5. The ISIT Tack Build-up times for the invented papers are over 150 s as the values for the known papers are less than 25 s.

The ISIT Tack Build-up curves and ISIT Tack Build-up times ISIT Tack Build-up time for one known paper both with Sun Challenge and with SICPA Mediatech Ultra Fast ink are presented in picture 6. The values for the known paper are less than 10 s.

5.4 K&N Ink Absorption test and Gurley-Hill porosity

The K&N Ink Absorption and Gurley-Hill results were following for four invented papers and for known papers.

K&N

Coating colour 3 / sample 12	1.5
Coating colour 5 / sample 8	1.3
Coating colour 6 / sample 10	1.3
UPM Cote 60 gsm	7.7
UPM Ultra 70 gsm	15.5

The invented papers have much lower ink absorption.

5.5 Ink

1. Sun Challenge

T_{\max} value for Sun Challenge ink was 286 s and for SICPA Mediatech Ultra Fast the values were between 100 – 150 s.

Ink Colour Hue Lot	SICPA Mediatech Ultra Fast				Sun Challenge
	Yellow	Magenta	Cyan	Black	Cyan
	2300K	5000K	6700K	9000K	3925-02
	183480	183481	183482	183483	95364
Tack (100 m/min)	128	120	112	120	169
Stability (200 m/min) Start	153	128	118	130	176
Max	164	132	121	138	196
Stability T_{\max} (s)	150 s	108 s	101 s	145 s	286 s

5.6 Conclusion

The invented papers have clearly more closed surface than the known papers have. The SICPA Mediatech Ultra Fast loses the solvent much

faster the Sun Challenge and is therefore more favorable for low temperature in heatset offset drying.

One can state according to the results that the known uncoated super calendered paper UPM Max 56 g/m² (SCO) has a long ISIT Tack Build-up time over 100 s and a high IGT Set-off value of 0,50 print density units at 30 s delay time because the capillary suction of UPM Max is slow due to the large pore radius of an uncoated paper that can be concluded from the low Gurley Hill Air Permeance value that is clearly under 1000 s. It is possible to make a difference between the uncoated porous supercalendered papers and non-porous coated papers with the Gurley-Hill Air Permeance method.

6 Printing method

An example of the concept of the heatset offset method meant for the invented paper is described here:

Printing machine:	Albert Frankenthal A101-S
Printing Speed:	6,2 m/s
Printing ink:	SICPA Mediatech Ultra Fast
Fountain solution:	3 % of SICPA Sol Alcofree additive, 97 % tap Water
Drying:	Web end temperature 95 °C
Length of the dryer	8 m

The printed product can also be printed with similar ink in other printing conditions and by using other raw materials in the printing process.

Another paper with the invented properties is presented that can be used in addition to the heatset offset method also with gravure printing method. The stages in papermaking are the same as before mentioned but coating recipe is following:

Talc (C10XO)	60 parts
Kaolin (Supragloss 95)	40 parts
CMC (FinnFix 10)	0.8 parts
Styreine maleic acid (Raiprint D200)	1 part
Calcium stearate (Raisacoat 50)	0.5 parts
Optical brightener (Optiblanc NF)	0.2 parts

The solid content of the coating colour was 59 % and pH 8.0. Target coat weight was 10 + 10 g/m². Moisture content target before calendaring was

5.5 %. The base papers were LWC base papers containing 40 % of chemical pulp and 60 % of mechanical pulp (ground wood) and the basis weights were 43 and 41 g/m². The smoother side (upper side) was coated first. The calendering temperatures (upper/middle/lower) were 100 °C, 90 °C and 80 °C.

The paper fulfils the requirements for a heatset offset paper but in addition to that also the smoothness and compressibility requirements for a gravure paper have been taken into account in the coating recipe. For this reason the starch in the recipe has been taken away and the latex is even softer (T_g -20 °C)

A third paper with the invented properties is presented that resembles more a supercalendered SC-paper. The stages in papermaking are the same as before mentioned but coating recipe is following:

SB-latex (Rhodopas SB388)	100 parts
Talc (C10XO)	100 parts

The solid content of the coating colour was 20,0 % and pH 7,8 and the coating method was two-sided Sym Sizer. Target coat weight was 2 + 2 g/m². Moisture content target before calendaring was 5,3 %. The base paper was typical SC-paper with an ash content of 30 % and a fiber mix of 20 % chemical pulp and 80 % mechanical . The basis weights were 56 g/m². The calendering temperatures (upper/middle/lower) were 100 °C, 90 °C and 80 °C.

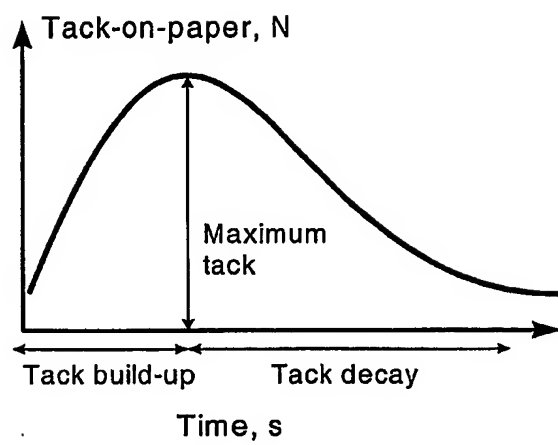
The papers can be coated with different coating and calendaring methods and the base paper can consist of different raw materials. The coating recipes can be used for coating a board enabling the possibility of using the heatset offset printing method. The drawings and the thereto attached description is only intended to clarify the inventive concept. In detail, for example pigments, furnishes, coating binders, coating and calendaring methods, uncoated papers for example SC-papers or boards, the invention may vary within the scope of the claims.

Patent claims

1. Printed substrate comprising a substrate with an oleophilic surface having a Gurley-Hill permeance value bigger than 5000s/100ml, the ink printed on the substrate having an IGT ink set-off value bigger than 0,60 print density units at 30s delay time.
2. Printed substrate according to the claim 1, **characterised** in that ISIT Tack Build-up time is over 100 s for ink whose stability value in Tack-O-Scope tack measurement is between 270 – 300 s.
3. Printed substrate according to the claim 1 or 2, **characterised** in that for Tack Build-up time over 200 s preferably over 250 s with the mentioned ink. The IGT Set-off value at 30 s delay time mentioned patent demand 1 is preferably bigger than 0,70 print density units.
4. Printed substrate according to any of claims 1 to 3, **characterised** in that to be a coated or surface treated paper or board.
5. Printed substrate according to the claim 4, **characterised** in that the coating is consists of pigment material.
6. Printed substrate according to the claim 5, **characterised** in that the pigment is plate-like.
7. Printed substrate according to the claim 6, **characterised** in that the aspect ratio (the relation of the diameter to the thickness) of the pigment is bigger than 2 and preferably bigger that 4.
8. Printed substrate according to the claim 7, **characterised** in that the pigment is purely talc or a mixture of talc and kaolin.
9. Printed substrate according to any of preceding claims is **characterised** in that to be a heatset offset printing material.
10. Printing method performed in at least one printing unit under use of following substrate/ink combination:
 - the substrate has an oleophilic surface and is non-porous, i.e. has a Gurley-Hill permeance value bigger than 5000s/100 ml,
 - the pigment carrier/ink has an IGT ink set-off value larger than 0,60 print density units at 30s delay time.

11. Method according to claim 10, wherein the substrate is a surface treated paper or board web fed through at least one printing unit.
12. Printing method according to claim 10 or 11, **characterised** in that ISIT Tack Build-up time of the printed substrate is over 100 s for ink whose stability value in Tack-O-Scope tack measurement is between 270 – 300 s.
13. Printing method according to claim 10, 11 or 12, **characterised** in that heatset offset printing or gravure printing are used as a printing method.
14. The printing method according to any of claims 10 to 13 is **characterised** in that the web end temperature after the dryer of the printing machine is under 115 °C and preferably under 100 °C.
15. The printing method according to any of claims 10 to 14 is **characterised** in that the ink stability value in Tack-O-Scope tack measurement is under 200 s.

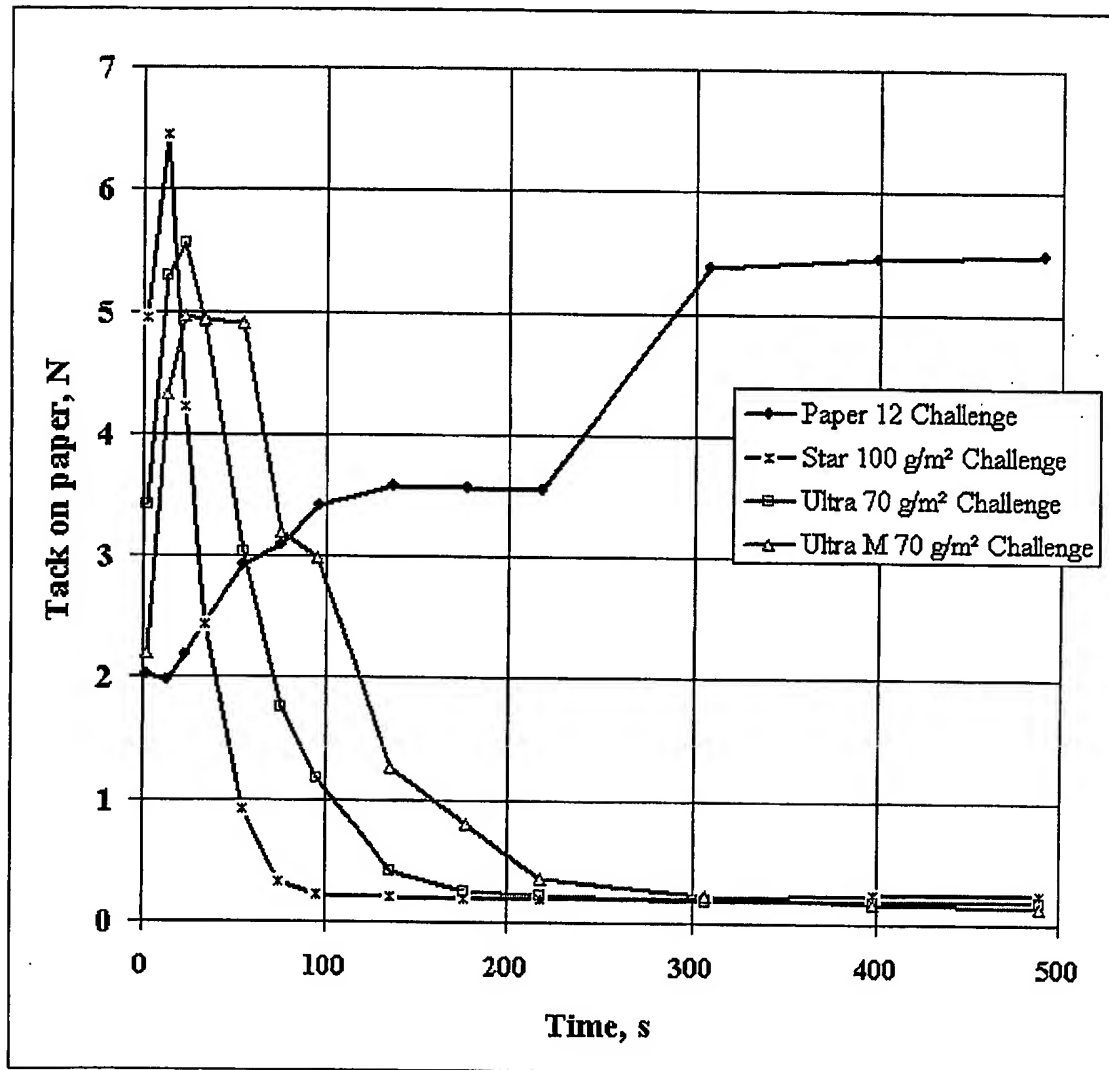
1/6



Picture 1. ISIT Tack Build-up curve

2/6

Picture 2. Legends and corresponding papers: Paper 12 = coating colour 3 / sample 12, Star = UPM Star 100 g/m², Ultra = UPM Ultra 70 g/m², Ultra M 70 = UPM Ultra M 70 g/m².



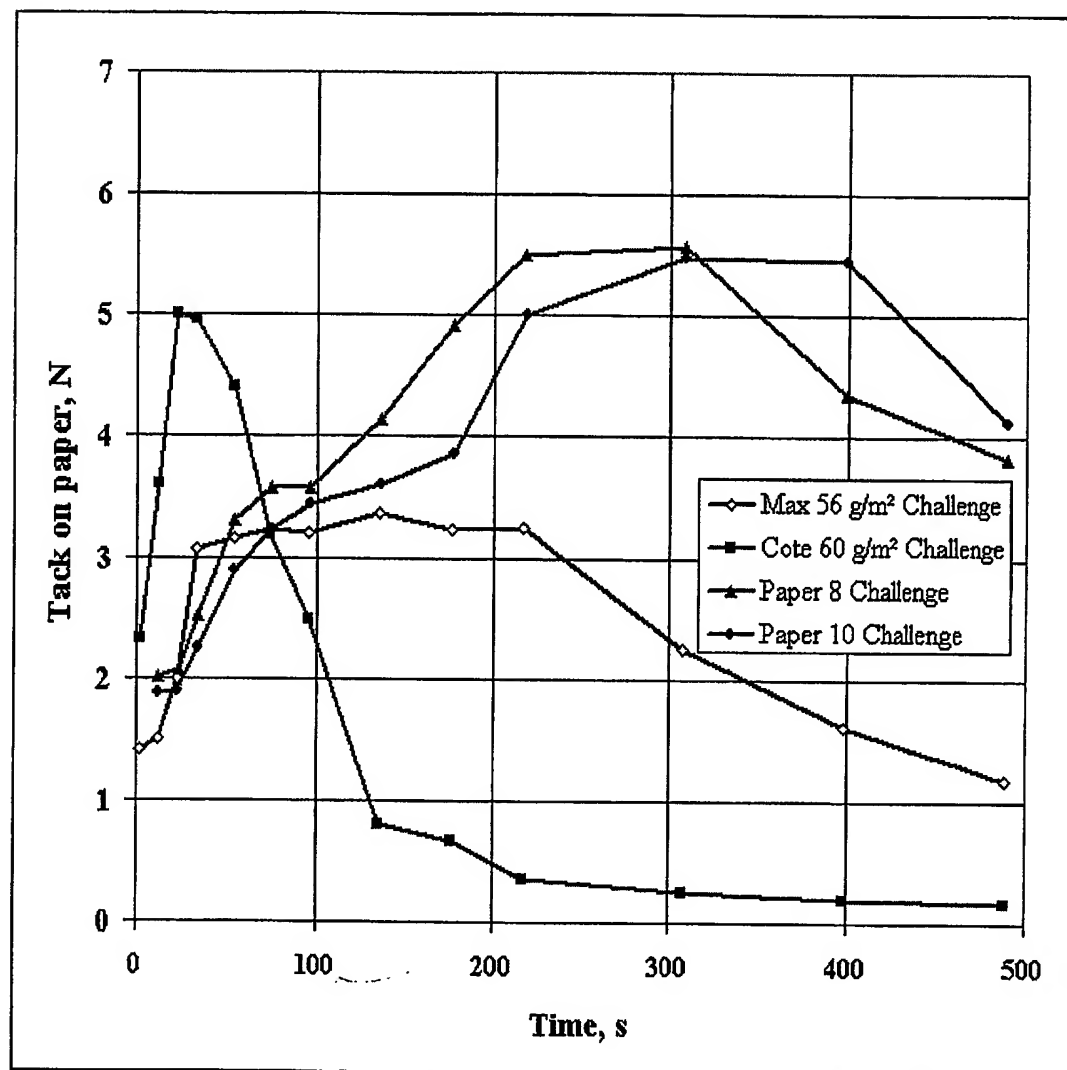
ISIT set-up

Printing speed (m/s):	0.5	Ink:	Sun Challenge
Contact hold time (s):	0.5	Ink amount (g/m ²):	1.4
Contact force (-):	8		
Pull-off speed (-):	5		

	Paper 12	Star 100 g/m ²	Ultra 70 g/m ²	Ultra M 70 g/m ²
Tack build-up (s):	489.9	12.5	23.0	23.1
Maximum tack (N):	5.5	6.5	5.6	5.0
Tack decay (s):		83	153	194

3/6

Picture 3. Legends and corresponding papers: Max = UPM Max 56 g/m², Cote = UPM Cote 60 g/m², Paper 8 = coating colour 5 / sample 8, Paper 10 = coating colour 6 / sample 10.

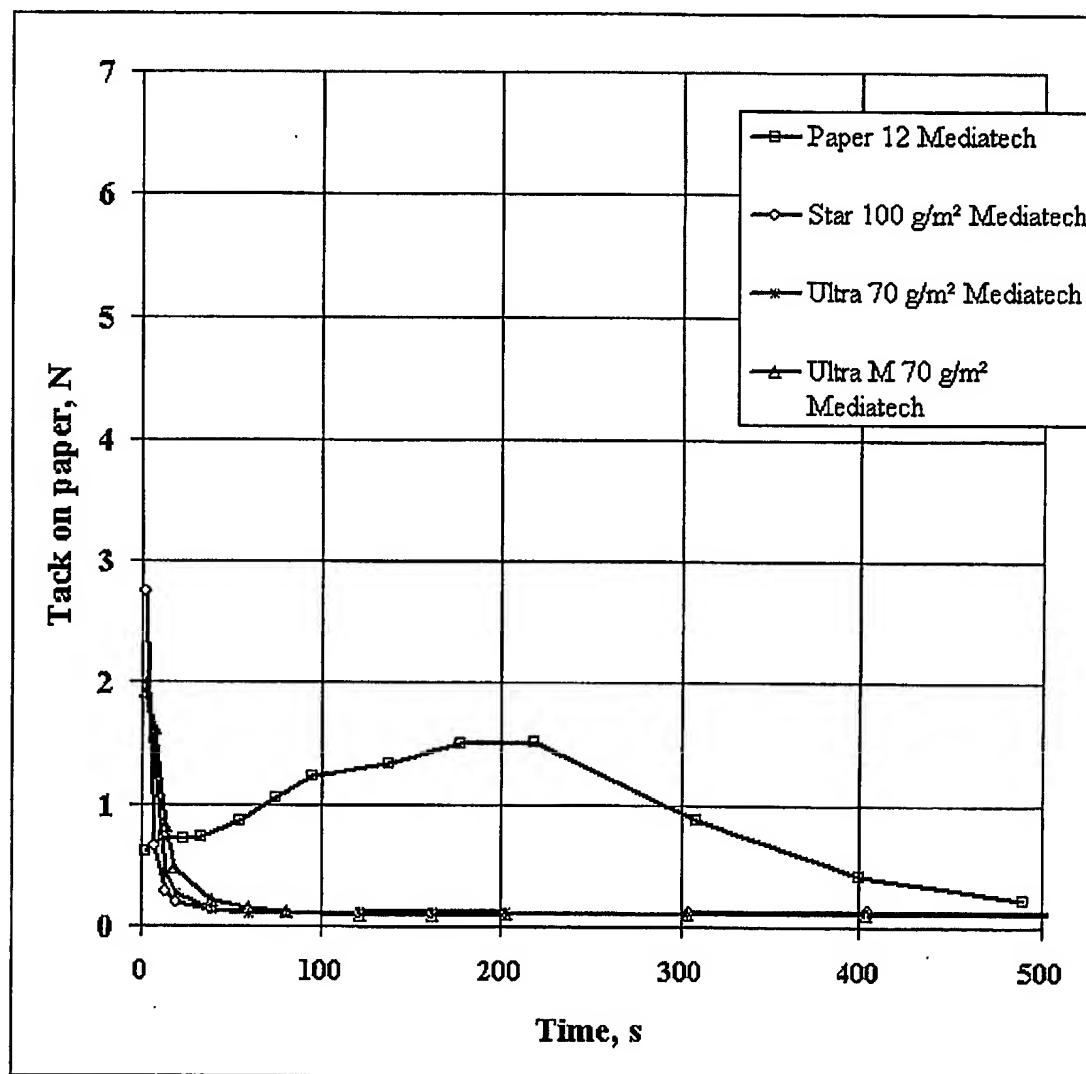
**ISIT set-up**

Printing speed (m/s):	0.5	Ink:	Sun Challenge
Contact hold time (s):	0.5	Ink amount (g/m ²):	1.4
Contact force (-):	8		
Pull-off speed (-):	5		

	Max 56 g/m ²	Cote 60 g/m ²	Paper 8	Paper 10
Tack build-up (s):	135.9	23.1	308.6	308.6
Maximum tack (N):	3.4	5.0	5.6	5.5
Tack decay (s):		194		

4/6

Picture 4. Legends and corresponding papers: Paper 12 = coating colour 3 / sample 12, Star = UPM Star 100 g/m², Ultra = UPM Ultra 70 g/m², Ultra M = UPM Ultra M 70 g/m².



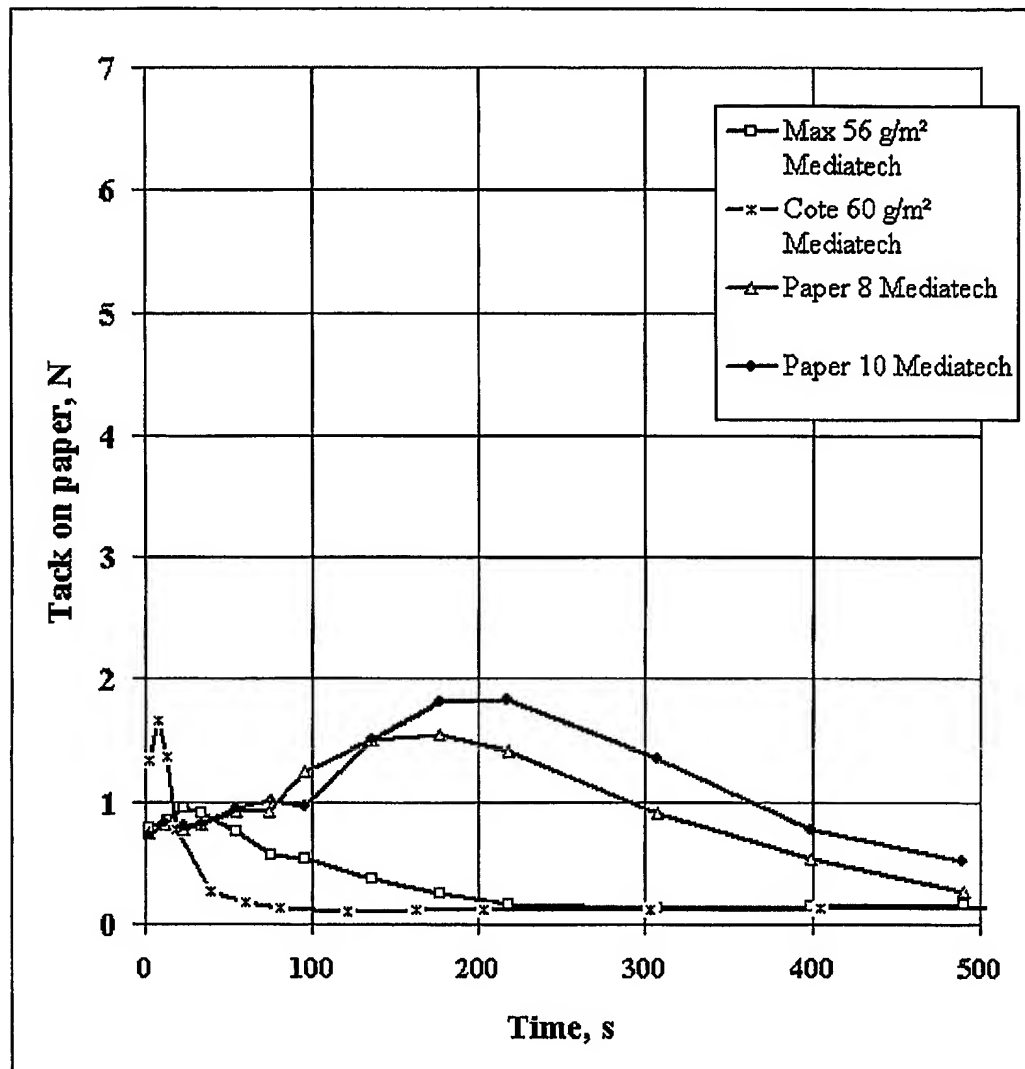
ISIT set-up

Printing speed (m/s):	0.5	Ink:	Sicpa Mediatech Ultra Fast
Contact hold time (s):	0.5	Ink amount (g/m ²):	1.5
Contact force (-):	8		
Pull-off speed (-):	5		

	Paper 12	Star 100 g/m ²	Ultra 70 g/m ²	Ultra M 70 g/m ²
Tack build-up (s):	217.9	1.9	1.9	1.9
Maximum tack (N):	1.5	2.7	2.0	1.9
Tack decay (s):	272	17	38	37

5/6

Picture 5. Legends and corresponding papers: Max = UPM Max 56 g/m², Cote = UPM Cote 60 g/m², Paper 8 = coating colour 5 / sample 8, Paper 10 = coating colour 6 / sample 10.

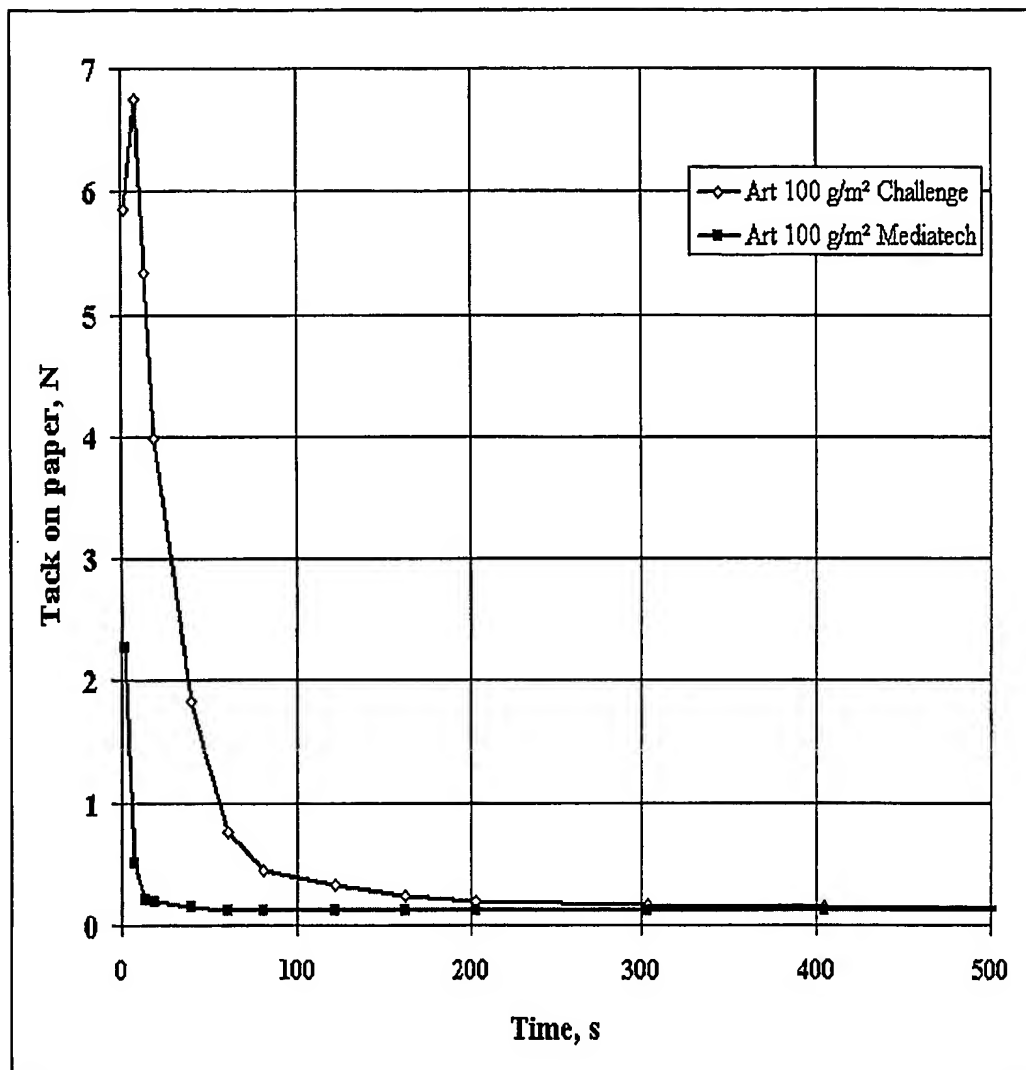


ISIT set-up

Printing speed (m/s):	0.5	Ink:	Sicpa Mediatech Ultra Fast
Contact hold time (s):	0.5	Ink amount (g/m ²):	1.5
Contact force (-):	8		
Pull-off speed (-):	5		

	Max 56 g/m ²	Cote 60 g/m ²	Paper 8	Paper 10
Tack build-up (s):	23.3	7.5	177.0	217.6
Maximum tack (N):	1.0	1.7	1.5	1.8
Tack decay (s):	154	53	313	272

6/6

Picture 6. Legends and corresponding papers: Art = UPM Art 100 g/m².

ISIT set-up		Ink	
Printing speed (m/s):	0.5	Ink:	Sicpa Mediatech Ultra Fst
Contact hold time (s):	0.5	Ink amount (g/m ²):	1.4 Sun Challenge
Contact force (-):	8		1,5 Sicpa Mediateckv Ultra Fast
Pull-off speed (-):	5		
		Art 100 g/m ² Challenge	Art 100 g/m ² Mediatech
Tack build-up (s):		7.7	1.9
Maximum tack (N):		6.8	2.3
Tack decay (s):		73	17

INTERNATIONAL SEARCH REPORT

Internat application No
PCT/EP 02/07130

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 D21H19/00 B41M5/00 C09D11/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 D21H B41M C09D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 376 162 A (ALEXANDER SPENCER ET AL) 2 April 1968 (1968-04-02) column 3, line 25 - line 30 ---	1-15
A	US 6 251 175 B1 (SIDDIQUI MOHAMMED ET AL) 26 June 2001 (2001-06-26) example 6 ---	1-15
A	WO 01 58697 A (3M INNOVATIVE PROPERTIES CO) 16 August 2001 (2001-08-16) the whole document ---	1-15
A	US 6 117 537 A (POPE JOHN A ET AL) 12 September 2000 (2000-09-12) column 2, line 17 - line 21 ---	1-15
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

26 February 2003

Date of mailing of the international search report

19/03/2003

Name and mailing address of the ISA

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Authorized officer

Spyropoulou, E

INTERNATIONAL SEARCH REPORT

Internati Application No
PCT/EP 02/07130

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 00 68021 A (CHAMPION INTERNAT CORP) 16 November 2000 (2000-11-16) page 5, line 15; claim 3 ---	1-15
A	US 5 863 639 A (VAIDYANATHAN AKHILESWAR G ET AL) 26 January 1999 (1999-01-26) claim 1 ---	1-15
A	DE 195 36 797 A (RICOH KK) 4 April 1996 (1996-04-04) the whole document ---	1-15
A	EP 1 101 623 A (SCHOELLER FELIX JUN FOTO) 23 May 2001 (2001-05-23) the whole document -----	1-15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP 02/07130

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: **Claims 1-15 partially searched**
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: Claims 1-15 partially searched

Present claims 1-15 relate to a printed substrate and a printing method defined by reference to desirable characteristics or properties, namely defined by the following parameters :

- a) the substrate has an oleophilic surface having a Gurley-Hill permeance value bigger than 5000s/10ml
- b) the ink printed on the substrate has an IGT ink set-off value bigger than 0.60 print density units at 30s delay time (claims 1, 10)
- c) ISIT Tack build-up time (claims 2,12).

The wording of the claims presently on file contain unusual parameters (the IGT ink set-off value and the ISIT tack build-up time are self-made parameters) and desiderata which render it impossible to determine the matter for which protection is sought.

The use of these parameters in the present context is considered to lead to a lack of clarity within the meaning of Article 6 PCT and it is impossible to compare the parameters the applicant has chosen to employ with what is set out in the prior art.

The lack of clarity is such as to render a meaningful complete search impossible.

Consequently, the search has been restricted only to non-porous printed substrates with oleophilic surfaces.

The initial phase of the search of non-porous substrates with oleophilic surfaces has revealed a very large number of documents relevant to the issue of novelty, some of which are cited in the present search report.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internal Application No

PCT/EP 02/07130

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3376162	A	02-04-1968	GB 1134742 A 27-11-1968
			AT 278052 B 26-01-1970
			BE 672683 A 23-05-1966
			CH 458074 A 15-06-1968
			DE 1447943 A1 23-01-1969
			DK 126453 B 16-07-1973
			FR 1460959 A 15-02-1967
			NL 6515127 A 24-05-1966
			SE 311817 B 23-06-1969
US 6251175	B1	26-06-2001	NONE
WO 0158697	A	16-08-2001	AU 4905701 A 20-08-2001
			EP 1263604 A2 11-12-2002
			WO 0158697 A2 16-08-2001
			US 2001036510 A1 01-11-2001
US 6117537	A	12-09-2000	AU 585499 B2 22-06-1989
			AU 4011785 A 03-10-1985
			DE 3583811 D1 26-09-1991
			DK 143085 A ,B, 30-09-1985
			EP 0156532 A2 02-10-1985
			JP 60214989 A 28-10-1985
			NO 851264 A 30-09-1985
			ZA 8501814 A 26-03-1986
WO 0068021	A	16-11-2000	AU 4844600 A 21-11-2000
			WO 0068021 A1 16-11-2000
US 5863639	A	26-01-1999	CA 2228996 A1 03-04-1997
			EP 0850330 A1 01-07-1998
			JP 11513442 T 16-11-1999
			US 6070635 A 06-06-2000
			WO 9712086 A1 03-04-1997
DE 19536797	A	04-04-1996	JP 8100388 A 16-04-1996
			DE 19536797 A1 04-04-1996
			GB 2293612 A ,B 03-04-1996
			US 5738759 A 14-04-1998
EP 1101623	A	23-05-2001	DE 19955081 C1 09-08-2001
			BR 0005397 A 18-09-2001
			CN 1295932 A 23-05-2001
			EP 1101623 A2 23-05-2001
			JP 2001199157 A 24-07-2001
			PL 343882 A1 21-05-2001